IT507 Advanced Image Processing
Assignment 3

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Q1. Decompose the Building image (Fig.1) into 8 bit planes. Show the bit planes. Then reconstruct the image back by removing three least significant bit planes. What will happen if you reconstruct the image by removing three most significant bit planes?

Theory:

- In the first question we have divided the Building *image* into 8 bit planes using a for loop and `np.bitwise_and` function of numpy library.
- As expected the most significant 3 bits contain the maximum information and the least significant 3 bits do not contain much information but are highly noisy images.

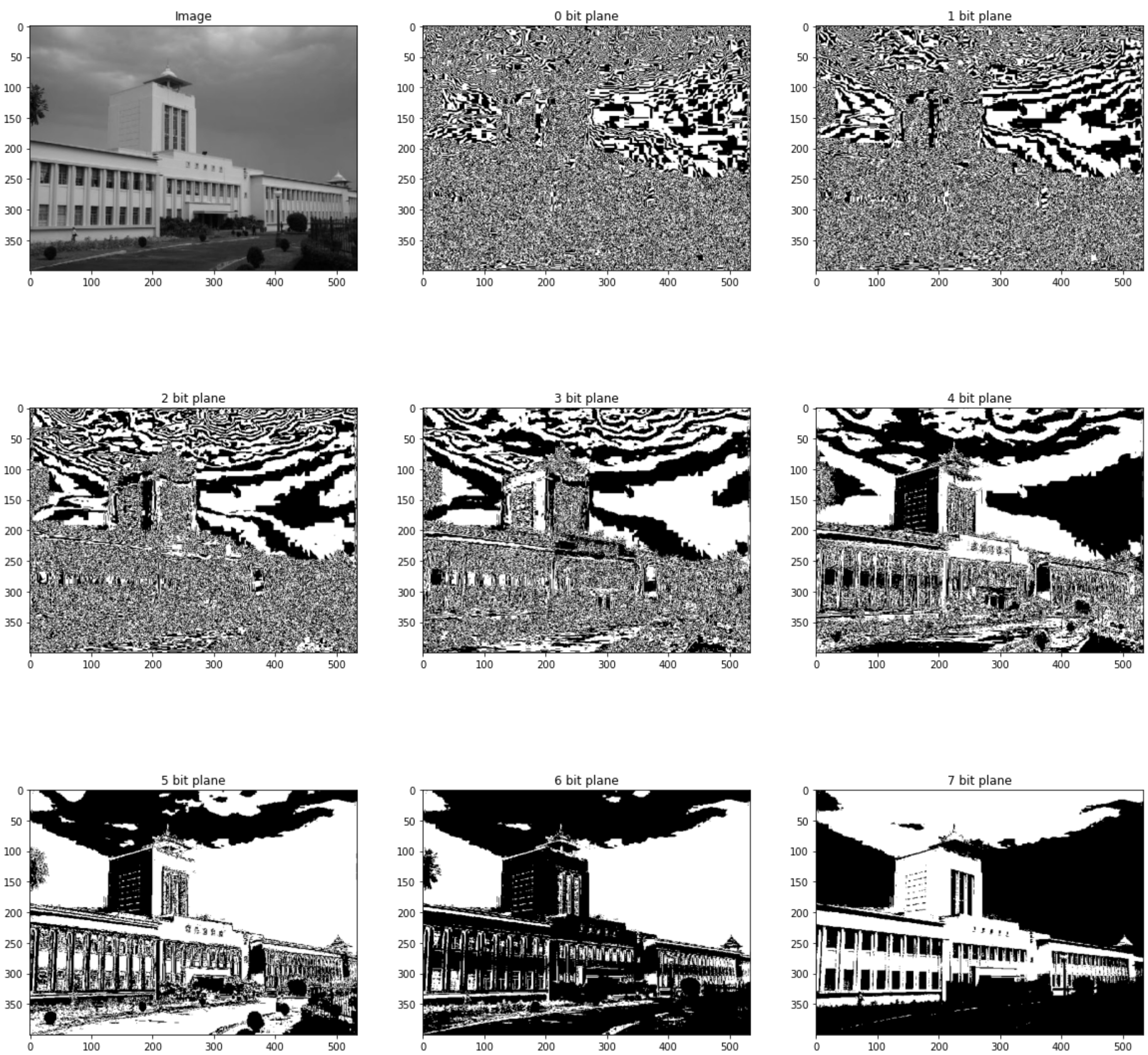


Fig-1 - 8 bit planes

- After obtaining the 8 bit planes we then reconstruct the image by removing the 3 least significant bit planes.

Fig2. - Image reconstructed using 5 bit planes

- The image obtained by reconstructing using the 5 most significant bit planes is similar to the image with 32 quantization levels we obtained in the first assignment.
- The final step is to reconstruct the image by removing the 3 most significant bits.

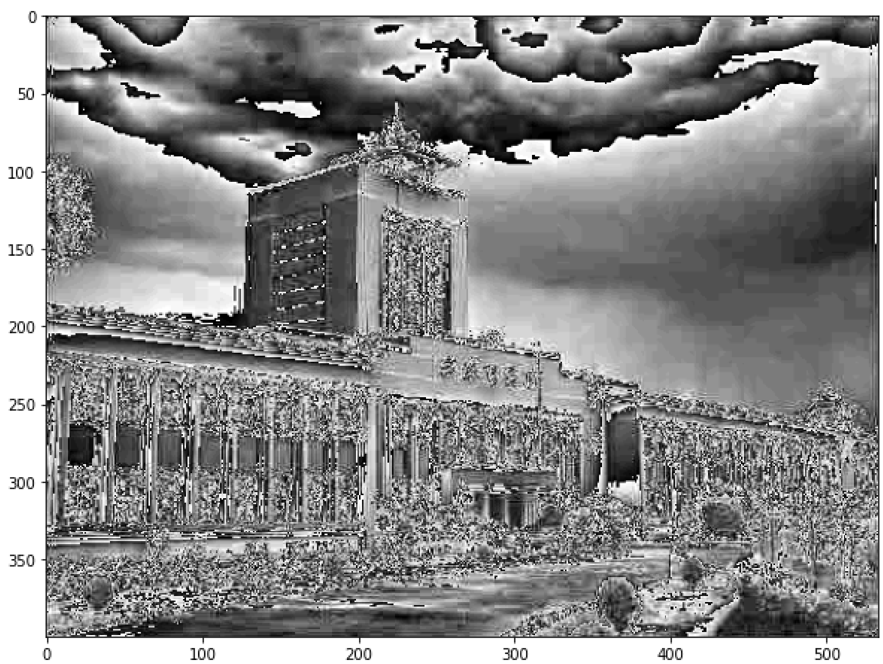


Fig-3. - Image reconstructed using 5 least significant bit planes

- We observe that the image is highly noisy for e.g. we cannot see the windows and plants in the surrounding area.

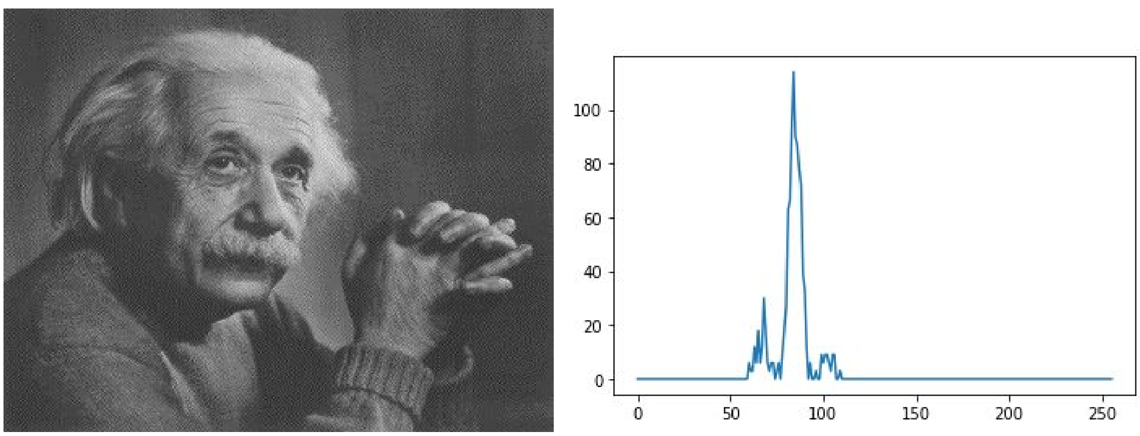
Q2. Write a program which will transform a given image (Fig.2(a)) in such a way that the resultant image histogram is equivalent to histogram of another image (Fig.2 (b)). In the process, show the individual histograms and the intensity transformation curve.

Histogram matching:

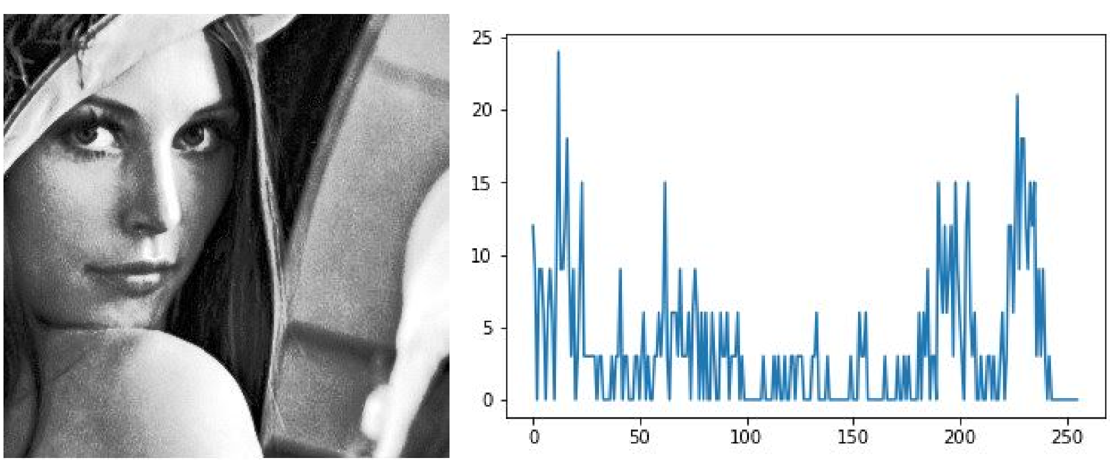
- Here we have two images and we will transfer the Fig(A) to Fig(result) in such a way that histogram matches with Fig(B).
- Here in the program we are using **matplotlib.pyplot , skimage** and **cv2** libraries**.**
- We can observe images from below images with histogram format. For this matching task we are using **skimage import exposure** library function **match_histograms().**
- It manipulates the pixels of an input image so that its histogram matches the histogram of the reference image. If the images have multiple channels, the matching is done independently for each channel, as long as the number of channels is equal in the input image and the reference.

Result:

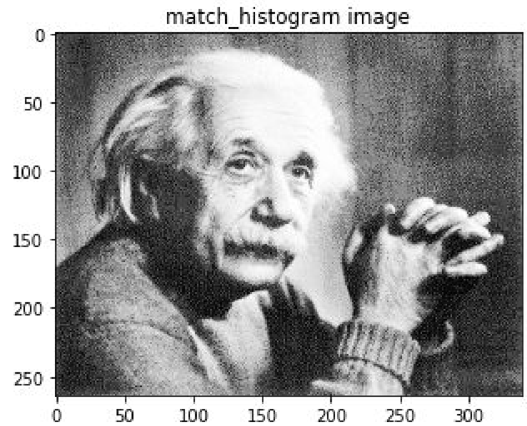
Fig(A):

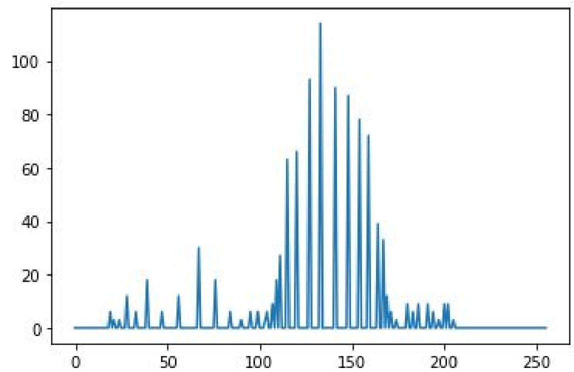


Fig(B):

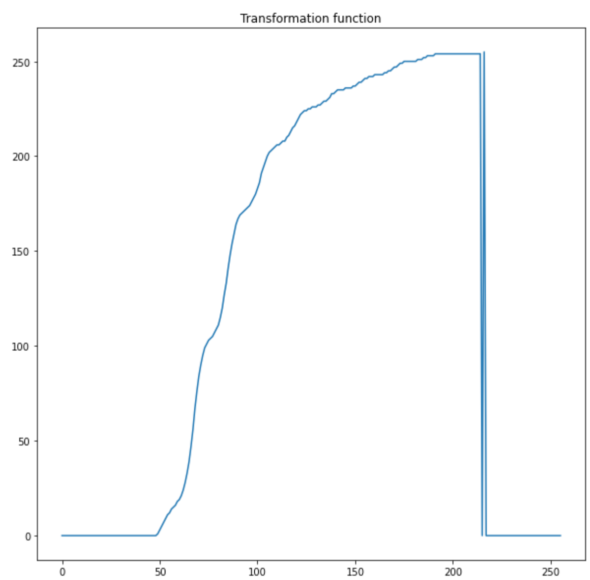


Fig(Result):





Transformation function:



Q3. Perform gamma transformation and histogram equalization (separately) on the given hazy image (Fig. 3 (a)) to enhance the contrast of the image.Now, consider the haze model I(x) = J(x)t(x) + A(1 − t(x)), where I(x) is the given hazy image. J(x) can be approximated with resultant image that have been generated by fusing the results of gamma transformation and histogram equalization. Assume the atmospheric light is A = [0.8159, 0.8186, 0.8272]. Now estimate the transmission map t(x) using the above equation. To see the accuracy of the results, compute the Euclidean distance between the estimated transmission map and the given transmission map. A lower distance indicates a better dehazing result.

Dehazing and gamma transformation:

- First we converted the image from RGB to HSV in order to perform histogram equalization.
- We perform histogram equalization on the V band by using `cv2.equalizeHist` of the open CV library. Fig - 4 represents the output after performing the above mentioned step.

Fig - 4. Output of Histogram Equalization

- Now to improve the contrast of the image we perform a gamma transformation.
- We choose gamma as 2 after a series of trial and error so as to get the best output. Fig- 5 represents the output after performing gamma transformation.

Fig - 5. Output after gamma transformation.

- Now we obtain t(x) in the equation, $I(x) = J(x)t(x) + A(1 - t(x))$.
- Here I(x) is our original hazy image, J(x) is the Fig-5(Dehazed image after histogram equalization and gamma transformation) and A = [0.8159, 0.8186, 0.8272] as per given in the question.

Fig - 6.t(x)

- Comparing our t(x) to t(x) given in the question the dissimilarities are clearly visible but the portion in the central region is darker in comparison to the other regions in both the t(x) which in fact the area where most of the hazing effect can be observed in the original image.
- The distance between both the t(x) is measured to be 128540.43450887177 which is a huge value and yet we can say that the t(x) we obtained is quite similar in essence.